RHIC BPM System

- Purpose of the task force
  - To provide consistently reliable working BPM system.
  - From the perspective of Operators and Accelerator Physicists, the system must just work.

RHIC BPM System

- Two major components
  - **System** – infrastructure, communication, cabling, etc.
  - **Measurements** – data triggering, processing, accuracy

The BPM Team

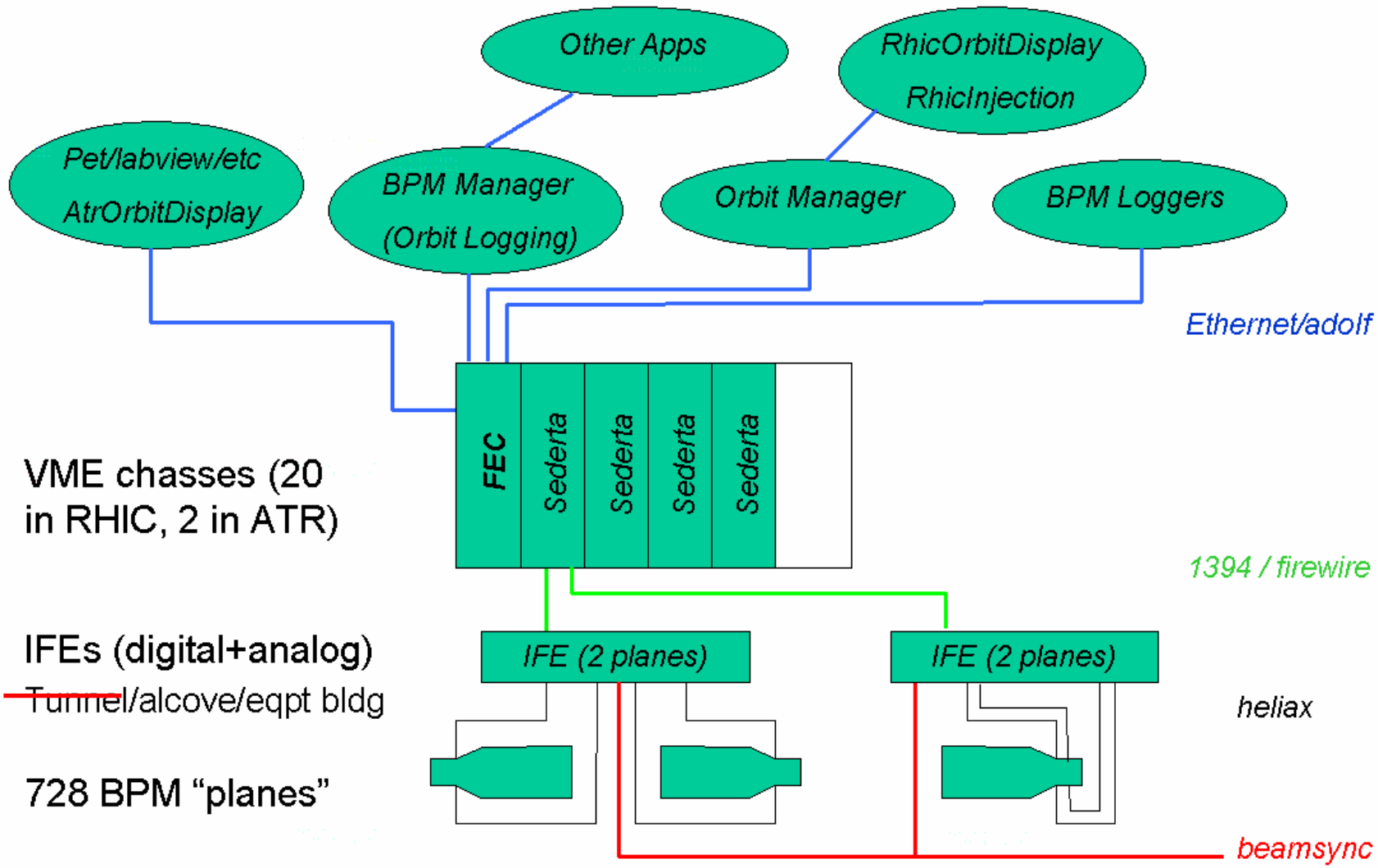
- Phil Cerniglia
- Tony Curcio
- Craig Dawson
- Chris Degen
- Justin Gullotta
- C.J. Liaw

- Others
  - John Cupolo
  - Joe Mead

- Siegfried Naase
- Bob Olsen
- Tom Russo
- Todd Satogata
- Ron Schroeder
- Bob Sikora

BPM System Overview

(Slide by T. Satogata)

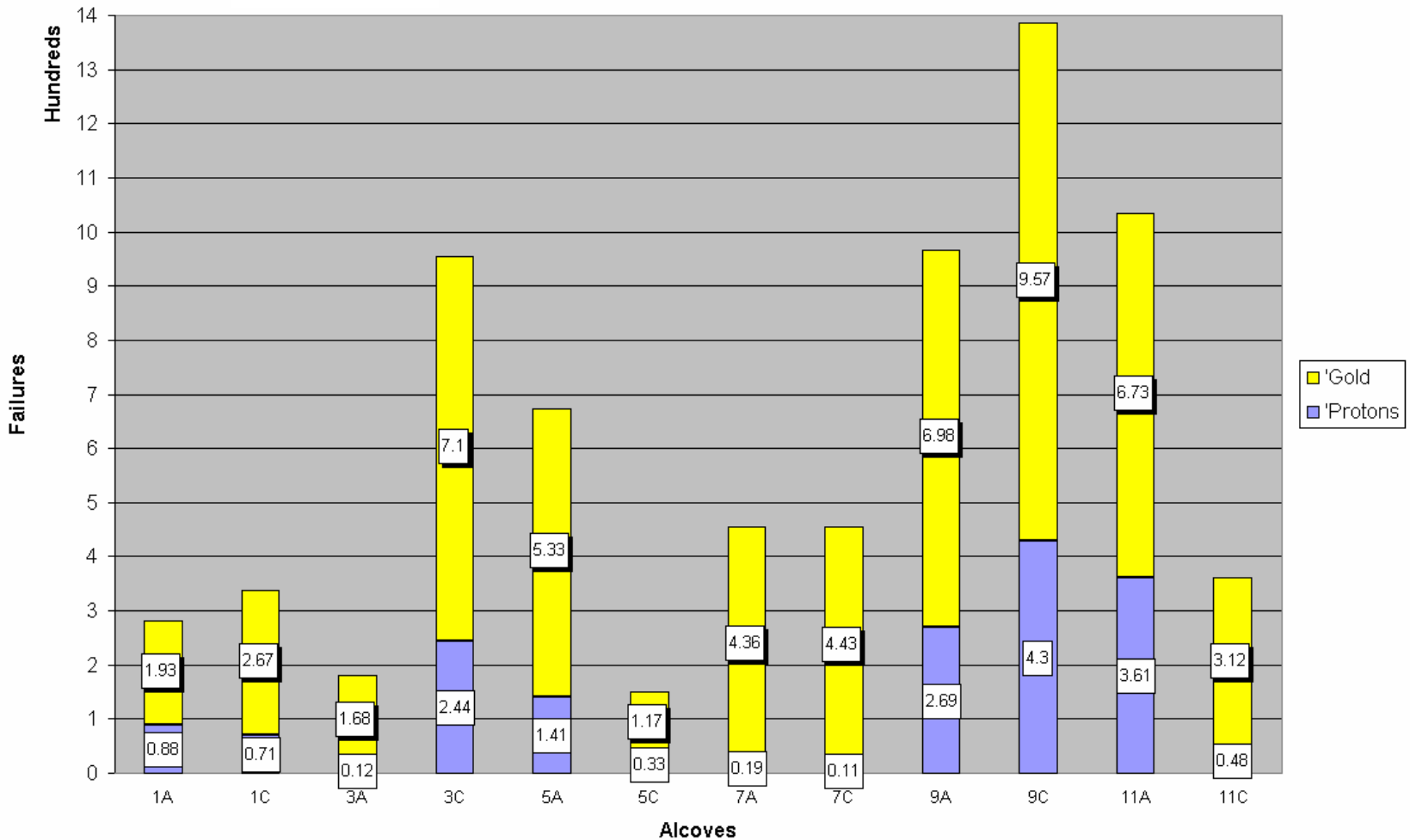


IFE Move to Alcoves

- VERY VERY VERY Successful

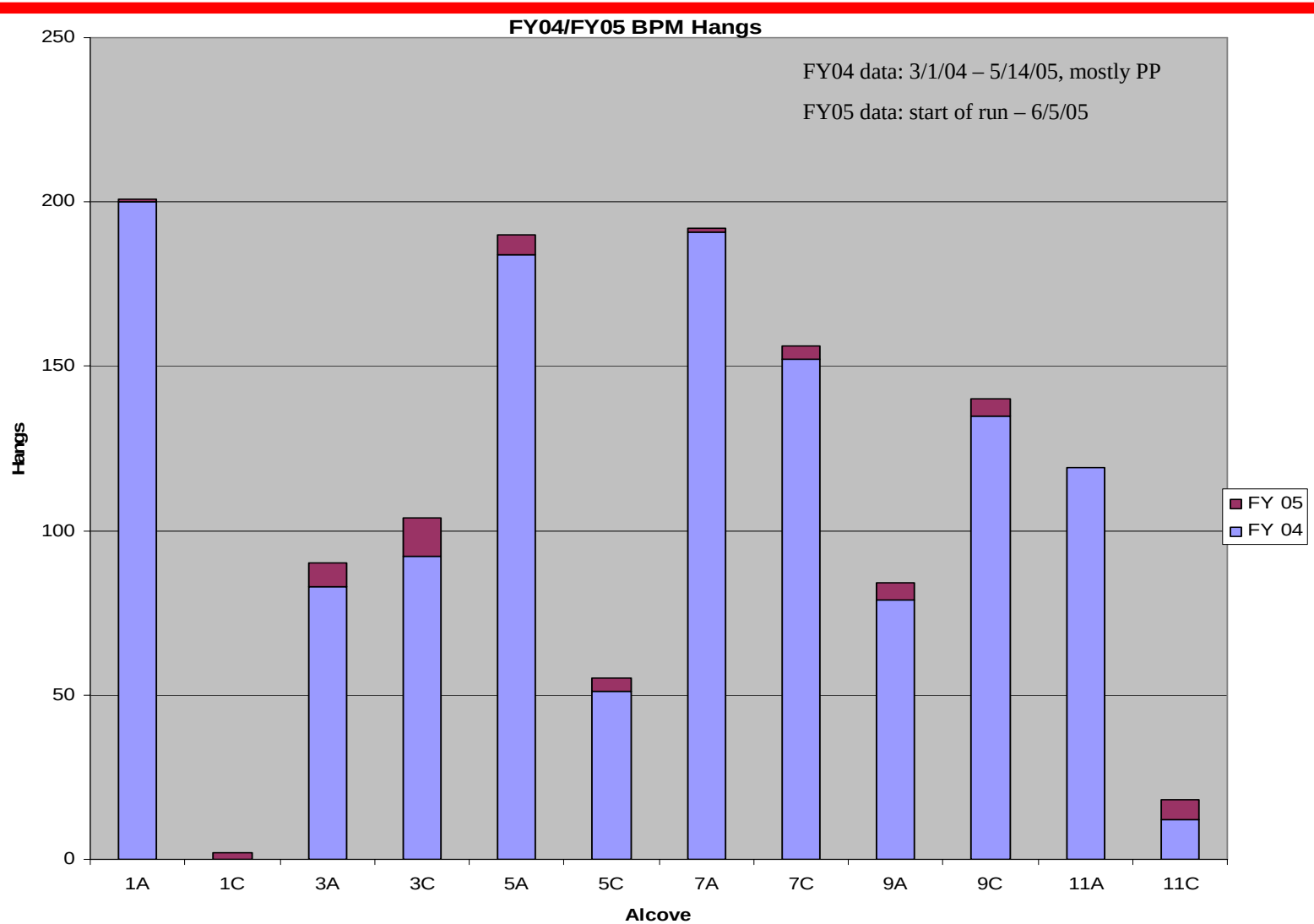
FY02 BPM Hangs

(Plot provided by P. Cerniglia)



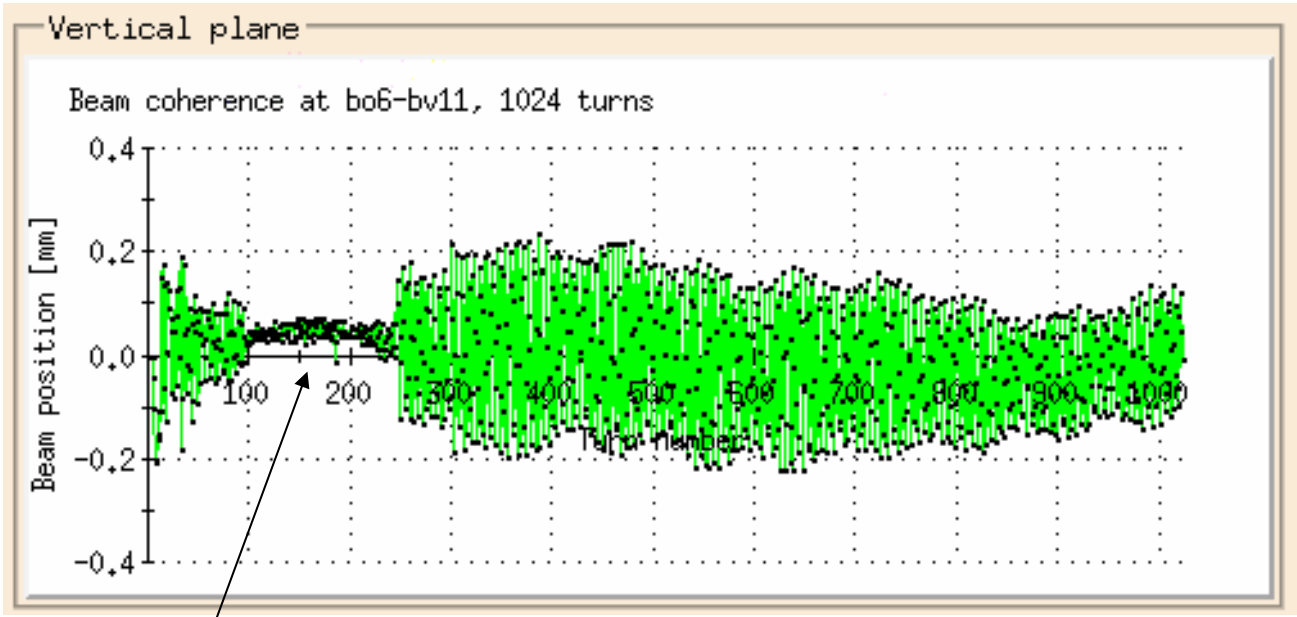
FY04/FY05 BPM Hangs

(Plot provided by P. Cerniglia)

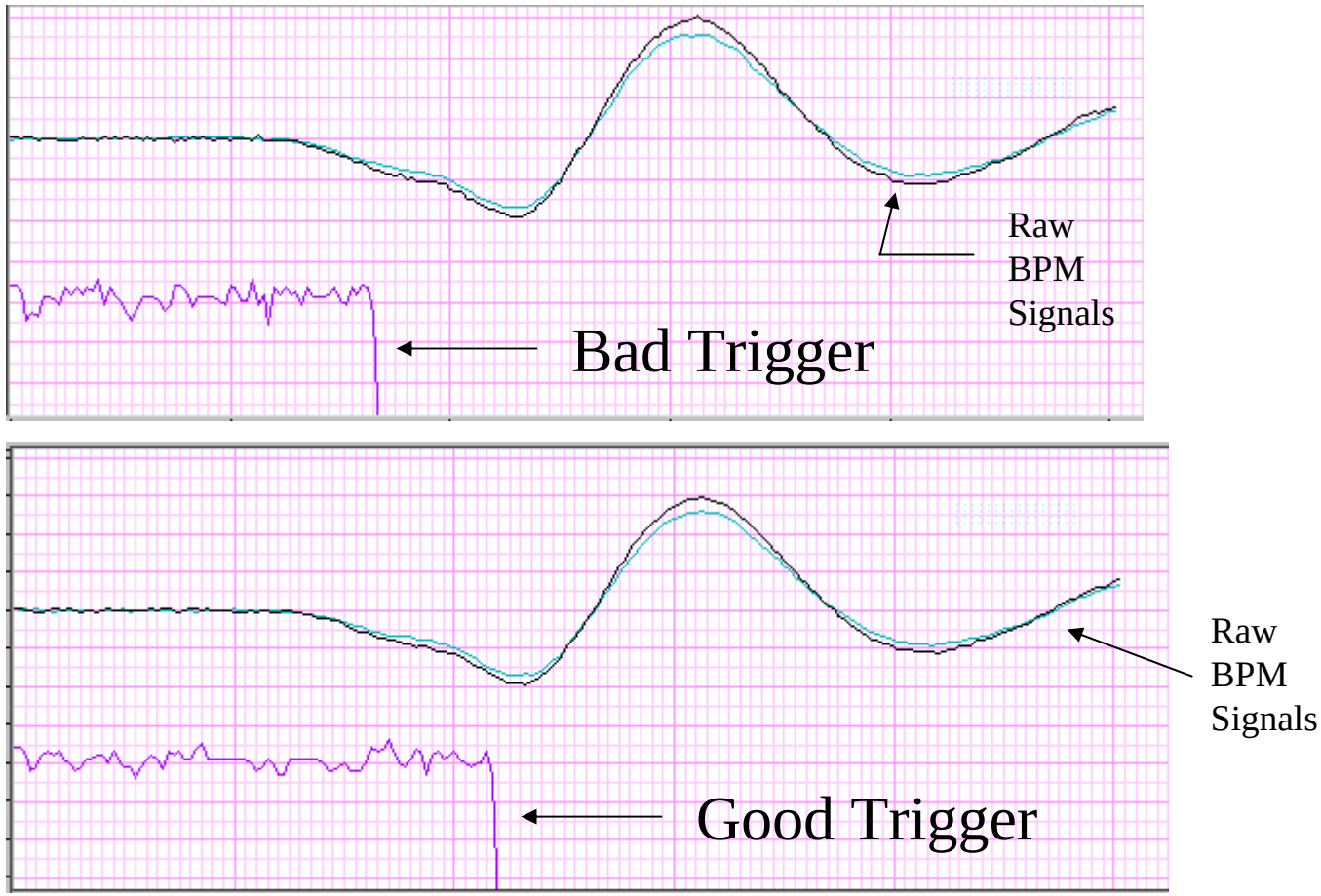


An explanation for one odd BPM behavior

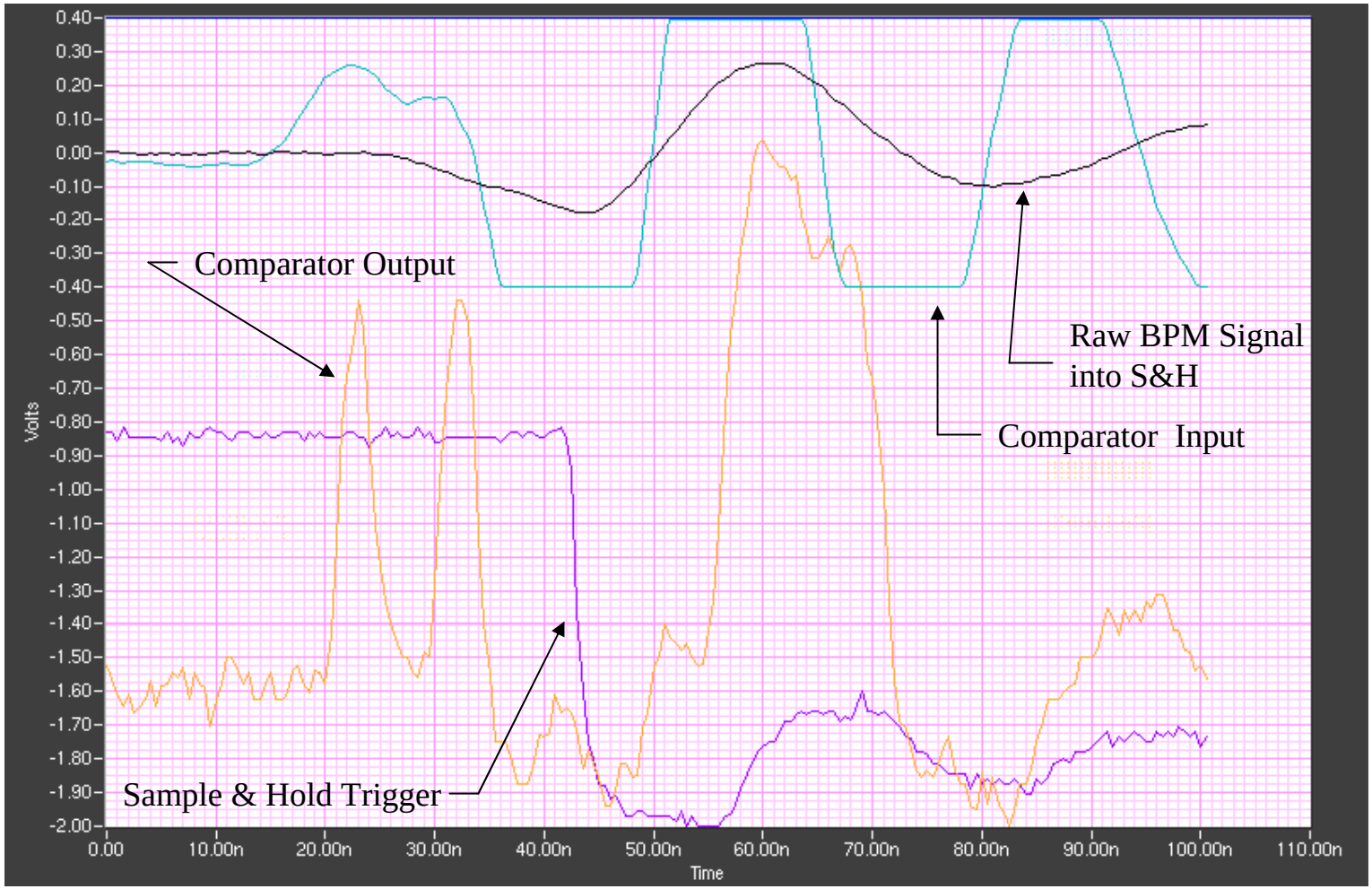
- Cause of unphysical amplitude change is jumping self-trigger



Good vs. Bad Auto-Trigger



BPM Self-Trigger Problem



BPM Self-Trigger Problem

- Slow BPM raw signal falling edge causes double comparator peak
- AC coupling capacitor value was increased, to correct the double triggers

Fixed-Trigger vs. Auto-Trigger

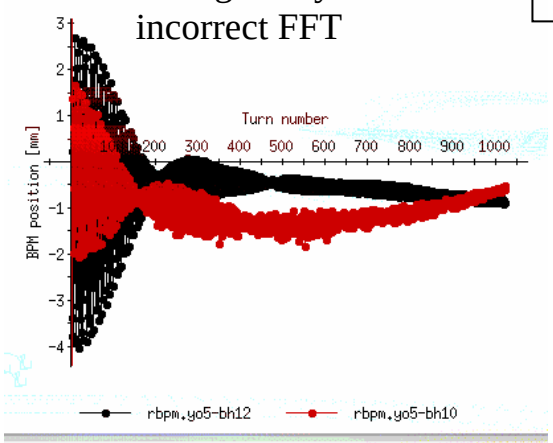
- Auto-Trigger
  - Major trigger jumping problem now understood and will hopefully be corrected by changing capacitor value
  - Some uncertainties may still exist
  - Measurements dependent on good threshold setting
- Fixed-Trigger
  - Provides guaranteed trigger position in bucket
  - Does not appear to shift significantly over time, but periodic confirmation of accurate timing is required
  - Timing is much more critical, and more complex to configure
  - Longitudinal motion at injection creates inaccurate measurement

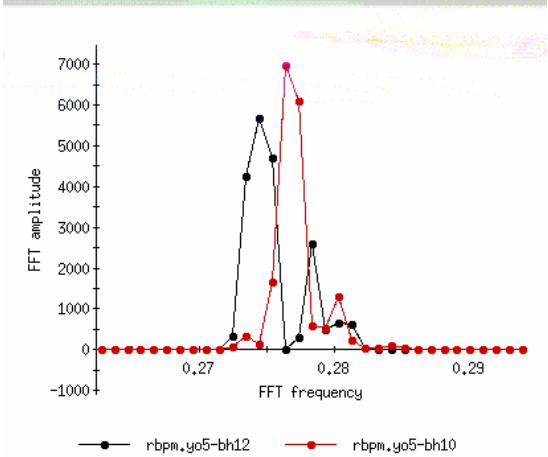
Fixed-Trigger vs. Auto-Trigger

yo5-bh12 – fixed trigger (blk)

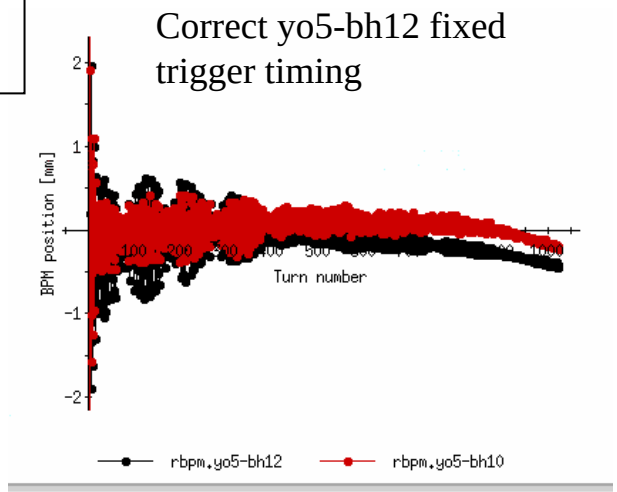
yo5-bh10 – auto trigger (red)

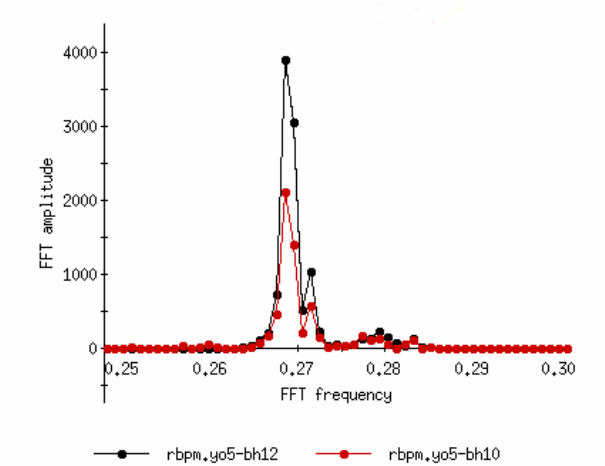
yo5-bh12 fixed trigger timing off by 3 ns causes incorrect FFT





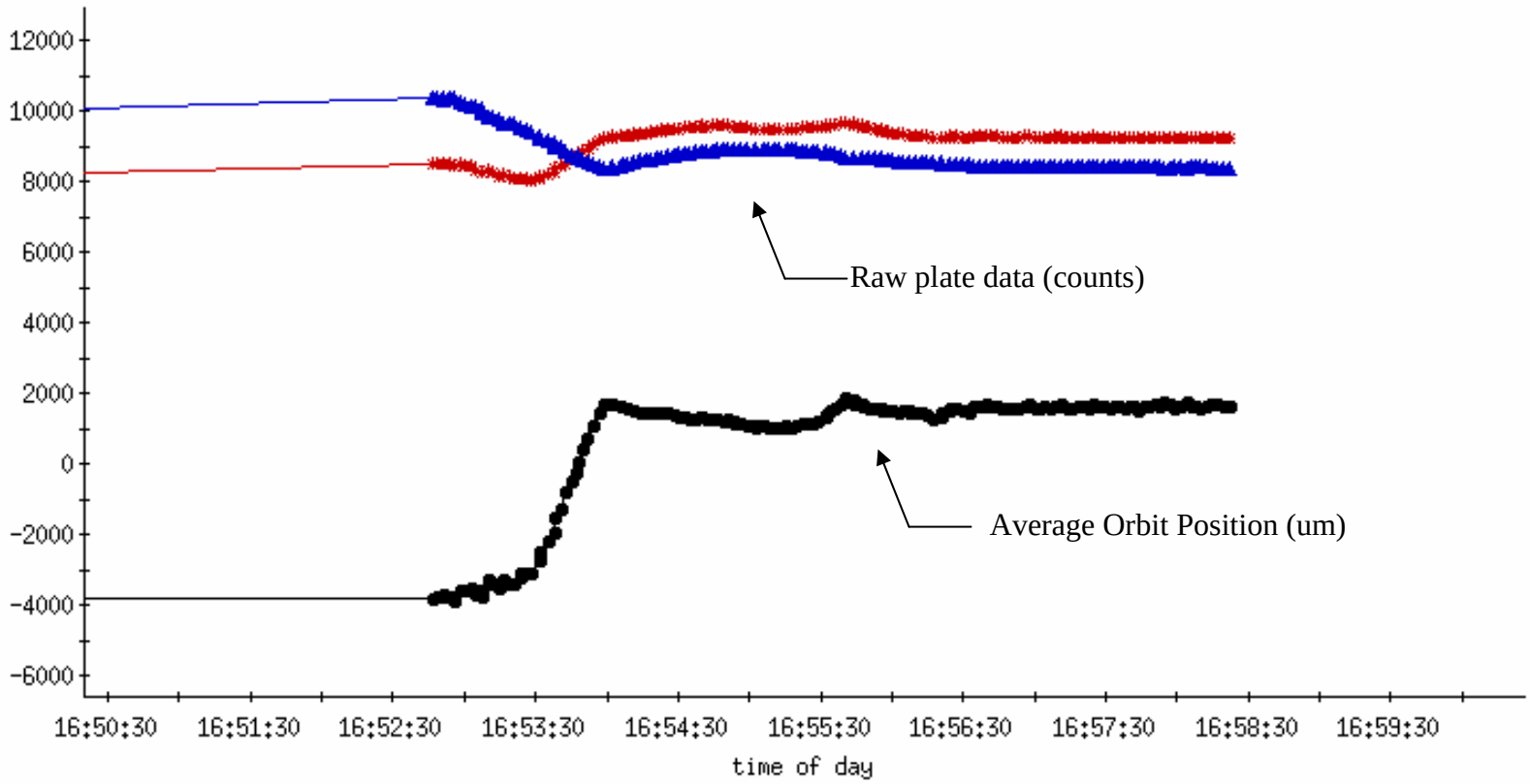
Correct yo5-bh12 fixed trigger timing





Fixed-Trigger Ramp

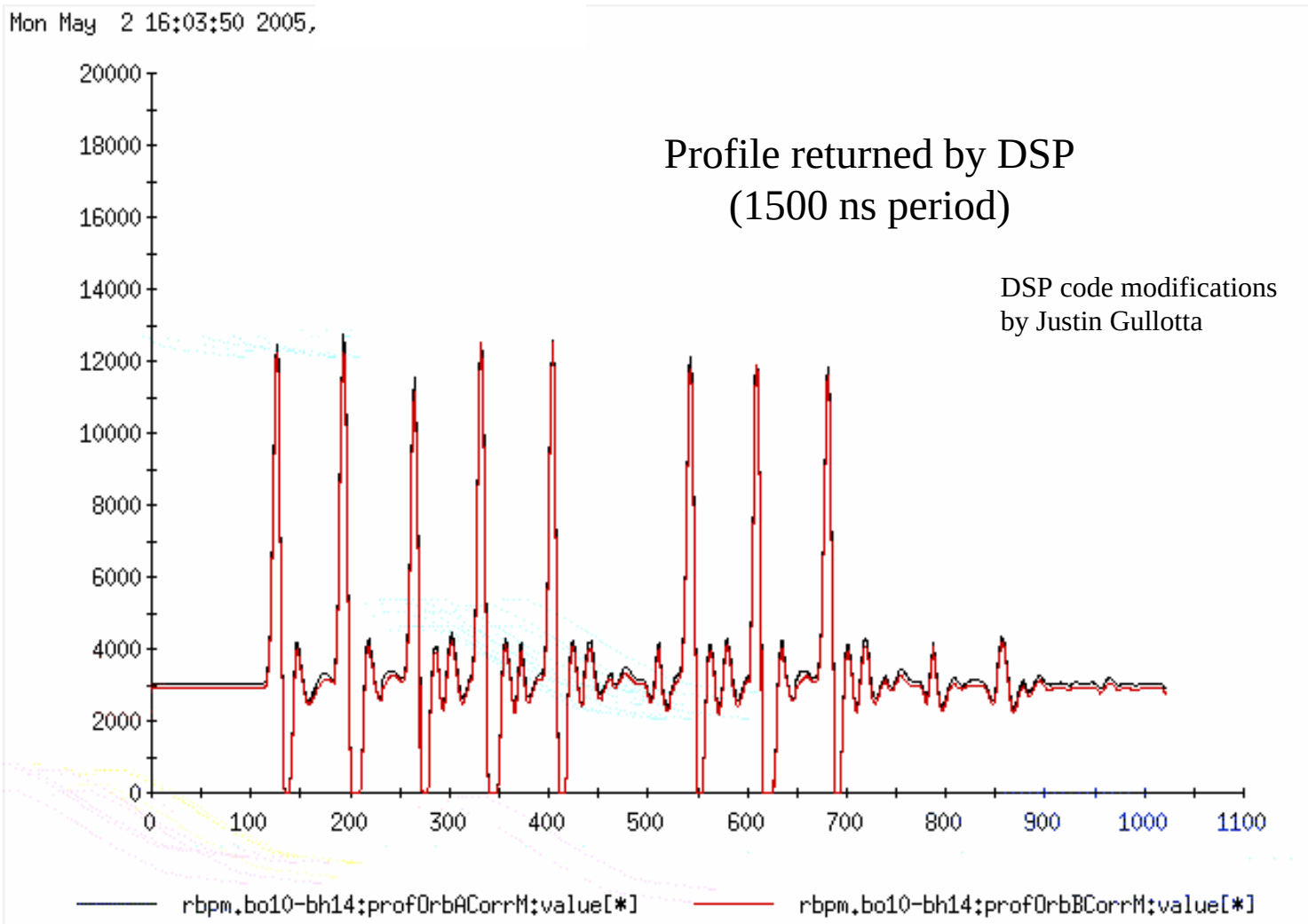
bo10-bh6 during ramp,
tracking fixed-trigger timing
based on revolution frequency



Fixed-Trigger vs. Auto-Trigger

- Proposed plan for next run
  - For initial beam, use self-trigger with large window
  - After establishing circulating beam and RF revtick, configure timing for fixed-trigger at injection
  - During first ramps, use auto-trigger by shifting timing by fixed value from fixed-trigger
  - At flattop, determine fixed-trigger timing and set revolution frequency adjust factor
  - “Push-button” timing configuration is needed
  - Absolute confirmation of timing is essential

BPM Profile



Profile returned by DSP
(1500 ns period)

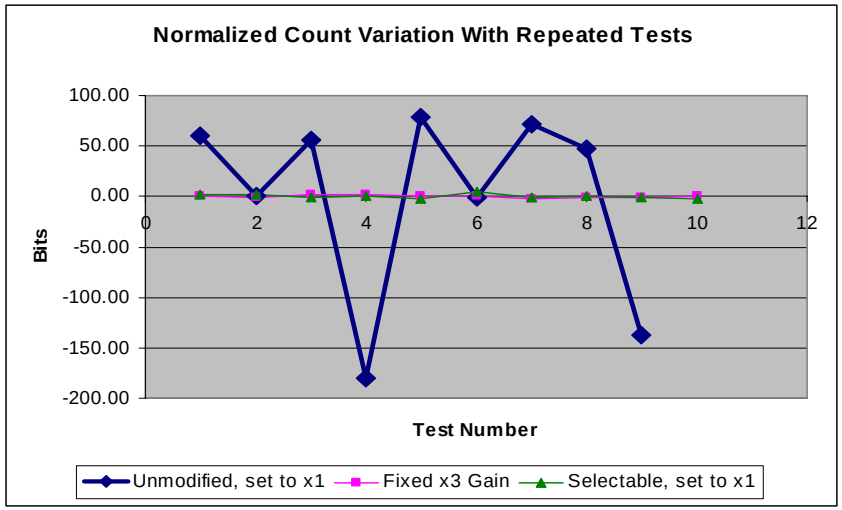
DSP code modifications
by Justin Gullotta

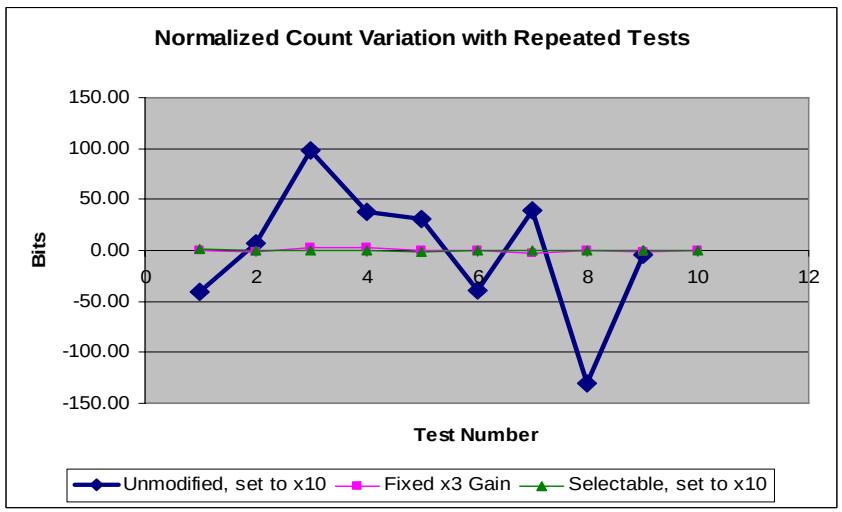
x1 and x10 Gain?

- Based on beam experiment on 6/13/2005, BPM measurements are marginal in x1 gain with intensity of 0.1 x 10^11 PP.
- Conclusion: Both x1 and x10 gain are required
- Craig Dawson developed and tested with beam, a prototype daughter board that uses analog switches/multiplexer instead of relays. Results are very encouraging.
- Can this be built and installed in all modules for next run? Cost and time estimate required.

Analog Switch vs. Relays

(Slide by C. Dawson)

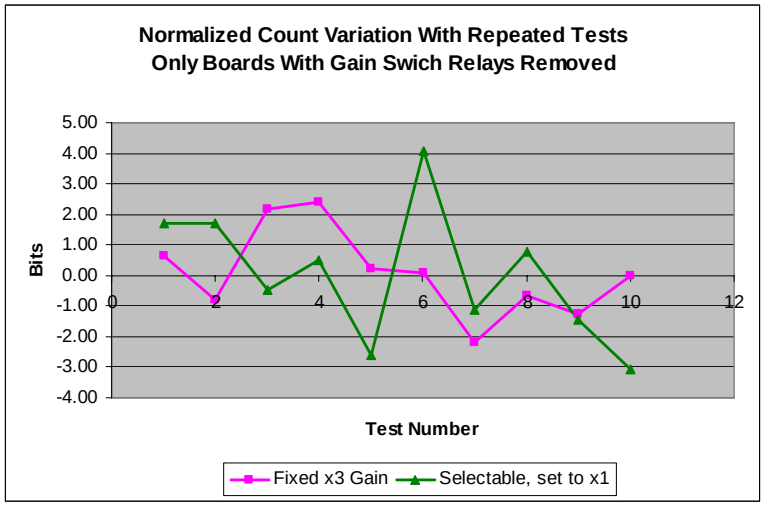


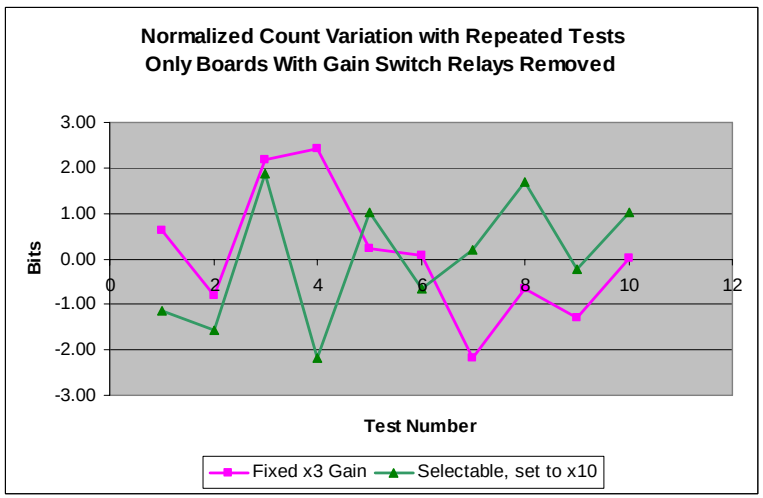


- Testing a BPM with an equal signal applied to both inputs results in large variations in ‘Acor-Bcor’ on the majority of boards with gain switch relays.
- The tests were performed with a LabVIEW vi that cycles the relays to select the appropriate gain during each test.
- Relay cycling is also performed during Calibration so results are not consistent.
- The data presented is typical (Many boards with relays are much worse.) but the offset has been removed to allow for clear comparison between boards.

Analog Switch vs. Relay Replaced with Jumper

(Slide by C. Dawson)





- The data for the boards without relays shows Acor-Bcor consistent within a few counts between tests.
- Gain switching is possible on only one board so the data for the board with fixed x3 gain is repeated for comparison.
- The results for x10 gain are better than for x1 gain for some unknown reason (signal levels are adjusted to half scale for all tests) but this is based on a sample of 1.

Cryogenic BPM Cables

- C.J. Liaw and Bob Sikora performed stress analysis on cables and connectors
- Warm side connectors are near stress limit
- ~20 cables are currently open and must be repaired
- Proposal: Repair all cables by re-soldering connector

Summary of Work

- Mechanical
  - Repair ~10 broken cryogenic feed-through assemblies
  - Repair ~20 open cryogenic cable connectors
  - Careful planning is required to prevent cable reversals
- IFE Hardware
  - Develop daughter board to replace relays with analog multiplexer to provide x1 and x10 gain (prototype testing with beam complete)
  - Replace capacitor to correct jumping auto-trigger problem
  - Track fixed-trigger timing up the ramp based on revolution frequency (proof-of-principle test with beam complete)
  - Continue debugging and repairing bad boards

Summary of Work

- Timing
  - Continue development of DSP code to deliver bunch profile
  - Automate timing setup
  - Track fixed-trigger timing up the ramp based on revolution frequency (proof-of-principle complete)
- Software/Firmware
  - Detailed analysis of calibration code is required
  - Proactive system diagnostics are required, provide alarms on communication/measurement problems
  - Track fixed-trigger timing up the ramp based on revolution frequency (proof-of-principle complete)
  - Inadvertent change to Service mode
  - Review normalization and engineering units conversion code
  - TBT data delivery on same start turn number
  - Provide bucket selection (1-360)